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FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **10191/1376**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) **09/554041**

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/DE99/02124	9 July 1999 (9.07.99)	9 Sept. 1998 (9.09.98)

TITLE OF INVENTION
PROBE FOR DETERMINING THE OXYGEN CONCENTRATION IN A GAS MIXTURE

APPLICANT(S) FOR DO/EO/US
LENFERS, Martin; STRASSNER, Walter; RIEGEL, Johann and **DIEHL, Lothar**

Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unsigned)
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report and PCT/RO/101.

Express Mail No.: EM360466107US

U.S. APPLICATION NO. if known, see 37 C.F.R.1.5	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/554041	PCT/DE99/02124	10191/1376

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17. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO .... $840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) .... $670.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) .... $760.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO .... $970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	7 - 20 =	0	X $18.00	$0	
Independent Claims	1 - 3 =	0	X $78.00	$0	
Multiple dependent claim(s) (if applicable)			+ $260.00	$	
TOTAL OF ABOVE CALCULATIONS =				$840	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$840	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$840	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$840	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $__________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of $840.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Richard L. Mayer BY: [illegible] (Reg. No. 41,172)

SIGNATURE

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004

Richard L. Mayer, Reg. No. 22,490
NAME

5/9/00
DATE

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[10191/1376]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Martin LENFERS et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	PROBE FOR DETERMINING THE OXYGEN CONCENTRATION IN A GAS MIXTURE
Examiner	:	To Be Assigned
Group Art Unit	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Please amend the above-identified application before examination as follows:

In The Specification:

On page 1, before line 1, insert --Field Of The Invention--.

On page 1, line 1, after "The" insert --present--.

On page 1, line 5, change "Background Information" to --Background Information--.

On page 1, delete line 6 and in its place insert --Previously proposed probes --.

On page 3, line 1, change "Advantages of the Present Invention" to --Summary Of The Invention--.

On page 3, lines 2-3, delete "having the features set forth in Claim 1".

EM360466107US

On page 4, delete lines 1-13 and in their place insert:

--<u>Brief Description Of The Drawings</u>

Figure 1 shows a section through the head of a probe.

Figure 2 shows an equivalent circuit diagram of a joint supply conductor of a Nernst electrode and an inner pump electrode of the probe.

Figure 3a shows one embodiment for influencing the resistances of the joint supply conductor according to Figure 2.

Figure 3b shows a second embodiment for influencing the resistances of the joint supply conductor according to Figure 2.

<u>Detailed Description</u>--.

On page 6, line 30, after "3" insert --a--.

On page 8, line 1 change "Patent Claims" to

--<u>What Is Claimed Is</u>:--

<u>In The Claims</u>:

Please cancel claims 1-5, without prejudice. Please also add new claims 6-12 as follows:

6. (New) A probe for determining an oxygen concentration in a gas mixture, comprising:

a Nernst measuring cell including:

a Nernst electrode exposed to the gas mixture to be measured via a diffusion barrier,

a reference electrode exposed to a reference gas, and

a solid electrolyte body arranged between the Nernst electrode and the reference electrode;

a pump cell including:

an inner pump electrode exposed to the gas mixture via the diffusion barrier,

an outer pump electrode exposed to the gas mixture, and

a solid electrolyte body arranged between the inner pump electrode and the outer pump electrode;

a joint supply conductor section through which the Nernst electrode and the inner pump electrode are connected at least in some sections to a circuit arrangement for controlling and evaluating the probe; and

a joint supply conductor resistor associated with the Nernst electrode and the inner pump electrode and including a loaded voltage divider, the loaded voltage divider including a plurality of resistors that are arranged such that a negative feedback of a Nernst voltage circuit and of a pump voltage circuit is optimized.

7. (New) The probe according to claim 6, wherein:

the negative feedback of the Nernst voltage circuit and of the pump voltage circuit is maximized.

8. (New) The probe according to claim 6, wherein:

the gas mixture corresponds to an exhaust gas of an internal combustion engine.

9. (New) The probe according to claim 6, further comprising:

an additional external resistor connected in series to the joint supply conductor section.

10. (New) The probe according to claim 6, wherein:

a cross section of the joint supply conductor section is minimized.

11. (New) The probe according to claim 10, further comprising:

printed conductor sections via which the Nernst electrode and the inner pump electrode are connected to a contact point, wherein:

the cross section of the joint supply conductor section is smaller than a cross section of the printed conductor sections.

12. (New) The probe according to claim 6, wherein:

the Nernst electrode and the inner pump electrode are connected to the circuit arrangement via the joint supply conductor section by a contact point, and

the contact point is located directly downstream of the Nernst electrode and the inner pump electrode at a first distance such that a second distance of the joint supply conductor section is of a maximum length.

In The Abstract:

Delete the present Abstract and in its place insert the following:

--Abstract Of The Disclosure

A probe is described for determining an oxygen concentration in a gas mixture, in particular in the exhaust gas of internal combustion engines, having a Nernst measuring cell, which has a first electrode (Nernst electrode) which is exposed to the gas mixture to be measured via a diffusion barrier, a second electrode (reference electrode) which is exposed to a reference gas, and a solid electrolyte body arranged between the first and the second electrode, and having a pump cell, which has a first electrode (inner pump electrode) which is exposed to the gas mixture via the diffusion barrier, a second electrode (outer pump electrode) which is exposed to the gas mixture, and a solid electrolyte body arranged between the first and the second electrode. The Nernst electrode and the inner pump electrode are connected at least in some sections via a joint supply conductor to a circuit arrangement for controlling and evaluating the probe. A joint supply conductor resistor of the Nernst electrode and of the inner pump electrode is formed by a loaded voltage divider whose individual resistors are arranged so that the negative feedback of a Nernst voltage circuit and of a

pump voltage circuit is optimized, in particular maximized.--.

Remarks

This Preliminary Amendment cancels claims 1-5, without prejudice, in the underlying PCT Application No. PCT/DE99/02124. This Preliminary Amendment also adds new claims 6-12. The new claims do not add new matter to the application but do conform the claims to U.S. Patent and Trademark Office rules.

The amendments to the specification and abstract are to conform the specification and abstract to U.S. Patent and Trademark Office rules. The amendments to the specification and abstract do not introduce new matter into the application.

The underlying PCT application includes a Search Report dated January 21, 2000, a copy of which is submitted herewith.

Applicants assert that the present invention is new, non-obvious, and useful. Consideration and allowance of the claims are requested.

Respectfully submitted,

KENYON & KENYON
By: Wes Mogata (Reg No. 41,172)

Dated: 5/9/00

By: Richard L. Mayer
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09/554041

2/PART

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[10191/1376]

PROBE FOR DETERMINING THE OXYGEN CONCENTRATION IN A GAS MIXTURE

The invention relates to a probe for determining an oxygen concentration in a gas mixture, in particular in the exhaust gas of internal combustion engines having the features set forth in the preamble of Claim 1.

Background Information

Probes of the type according to the definition of the species are known. Probes of this kind determine the oxygen concentration in the exhaust gas of internal combustion engines and are used to influence the setting of the fuel/air mixture during operation of the engine. The fuel/air mixture may be in the rich range, i.e., there is an excess of fuel in stoichiometric terms, so that only a small quantity of oxygen relative to other partly unburned components is present in the exhaust gas. In the lean range, in which there is a greater quantity of oxygen relative to the air in the fuel/air mixture, the oxygen concentration in the exhaust gas is correspondingly high. If the fuel/air mixture is of stoichiometric composition, both the amount of fuel and the amount of oxygen in the exhaust gas are reduced.

Lambda sensors which detect a lambda value > 1 in the lean range, a lambda value < 1 in the rich range, and a lambda value = 1 in the stoichiometric range and which are used to determine the oxygen concentration in exhaust gas are known. In this case, the lambda sensor supplies a detection voltage in a known manner, which is conveyed to a circuit arrangement. In known probes, with the help of the circuit arrangement the detection voltage is converted into a pump voltage for a pump cell, which is also a component of the probe and is exposed to the exhaust gas. The pump cell, in which oxygen ions are pumped from an inner pump electrode to an outer pump electrode or vice versa based on the oxygen concentration present. Depending on whether the lambda sensor detects a rich range, i.e., a lambda value < 1, or a lean range, i.e., a lambda value > 1, the circuit arrangement determines whether the outer pump electrode, which is connected to an active input of the circuit arrangement, is connected as a cathode or as an anode. The inner pump electrode of the pump cell is connected to ground, so that at the pump cell an anodic limit current flows in the case of rich measured gas

or a cathodic limit current flows in the case of a lean measured gas. In the case of stoichiometric operation, i.e., if the lambda value = 1, the pump voltage is close to 0, so that no limit current flows.

The detection voltage of the probe is determined via a Nernst measuring cell, which determines the difference between the oxygen concentration at a Nernst electrode and that at a reference electrode. The reference electrode is connected to a constant current source, while the Nernst electrode is connected to ground. As a result, the detection voltage is based correspondingly on the difference between the respective oxygen concentrations.

Because the Nernst electrode and the inner pump electrode of the probe are connected to ground, it is known that they can be connected to the circuit arrangement via a joint supply conductor. In this case, the electrodes are initially contacted inside the probe to separate printed conductors, which then come together inside the probe at a contact point to form the joint supply conductor.

By detecting the pump current of the pump cell required to maintain $\lambda = 1$ in a measuring space (hollow space) of the probe, it is possible to determine whether the fuel/air mixture used to operate the internal combustion engine is a rich or a lean mixture. If there is a change-over from a rich range to a lean range or vice versa, the pump current drops or increases, respectively. If the engine is being operated in the stoichiometric range, i.e., with a lambda value = 1, the pump current has a jump point that marks the transition from the lean range to the rich range and vice versa, respectively.

In known probes, it is disadvantageous that because the supply conductor of the Nernst electrode and the inner pump electrode is shared, at least in some sections, their joint supply conductor resistor, which is not only part of the Nernst voltage circuit of the Nernst measuring cell but also part of the pump voltage circuit of the pump cell, causes coupling, which has an impact on lambda = 1 ripple. This minimizes the counterswings and overswings in voltage that may occur in the event of a jump response in response to a transition from the rich range to the lean range.

Advantages of the Present Invention

By contrast, the probe according to the present invention having the features set forth in Claim 1 has the advantage that negative feedback of the pump voltage circuit and the Nernst voltage circuit is optimized. Because a joint supply conductor resistor of the Nernst electrode and of the inner pump electrode is formed by a loaded voltage divider whose individual resistors are arranged so that negative feedback of a Nernst voltage circuit and of a pump voltage circuit is increased, the lambda = 1 ripple can be reduced. The individual resistors are arranged so that when the detection voltage of the Nernst measuring cell transitions from the lean range to the rich range or vice versa, this produces a result via the jump point that triggers an anodic or cathodic limit current, respectively, via the pump cell, so that negative feedback via the joint supply conductor section of the Nernst measuring cell and the pump cell can be achieved.

According to a preferred embodiment of the present invention, an additional external resistor is connected in series to the joint supply conductor section of the Nernst measuring cell and the pump cell. Thanks to this additional external resistor, the total resistance of the joint supply conductor section is increased, so that at the constant current at which the Nernst measuring cell is operated the detection voltage is greater, so that the influence of negative feedback is increased by the cathodic or alternatively anodic limit current, which also flows through the additional resistor.

According to a further preferred embodiment of the present invention, a cross section of the joint supply conductor section is reduced. Reducing the cross section is another way to increase the resistance value of the joint supply conductor section, so that this is also a straightforward way of increasing negative feedback between the Nernst voltage circuit and the pump voltage circuit.

According to a further preferred embodiment of the present invention, the contact point where the printed conductor of the inner pump electrode meets the printed conductor of the Nernst electrode is moved spatially as close as possible to the electrodes, so that the length of the joint supply conductor section increases, so that the resistance of this joint supply conductor section is also increased by a defined amount.

Further preferred embodiments of the present invention are based on the other features described in the independent claims.

Drawings

The present invention will be explained in greater detail below with the aid of exemplary embodiments with reference to the associated drawings, in which:

Figure 1	shows a section through the head of a probe;
Figure 2	shows an equivalent circuit diagram of a joint supply conductor of a Nernst electrode and an inner pump electrode of the probe; and
Figure 3	shows various different embodiments for influencing the resistances of the joint supply conductor according to Figure 2.

Description of the Exemplary Embodiments

Figure 1 shows a section through a measuring head of a probe 10. Probe 10 is designed as a planar broadband probe and includes a plurality of individual layers which are arranged one above the other and may, for example, be structured via film casting, punching, screen printing, lamination, cutting, vitrification or other processes. The processes used to achieve layer structure will not be discussed in greater detail in the context of the present description, as this is known.

Probe 10 is used to determine an oxygen concentration in the exhaust gas of internal combustion engines, so as to generate a control signal for setting a fuel/air mixture used to operate the internal combustion engine. Probe 10 has a Nernst measuring cell 12 and a pump cell 14. Nernst measuring cell 12 has a first electrode 16 (Nernst electrode) and a second electrode 18 (reference electrode), between which a solid electrolyte 20 is arranged. Electrode 16 is exposed to exhaust gas 24 to be measured via a diffusion barrier 22. Probe 10 has a measuring opening 26 to which exhaust gas 24 can be supplied. Diffusion barrier 22 extends at the base of measuring opening 26, a hollow space 28 being formed within which electrode 16 is arranged. Electrode 18 of Nernst measuring cell 12 is arranged in a reference air channel 30 and exposed to a reference gas, e.g., air, present in reference air channel 30. Solid electrolyte 20 is made of, for example, yttrium-oxide-stabilized zirconium oxide, while electrodes 16 and 18 are made of, for example, platinum.

Probe 10 is connected to a circuit arrangement 32 (only indicated here) which evaluates the signals of probe 10 and controls the probe. Electrodes 16 and 18 are connected to inputs 34 and 36, respectively, of circuit arrangement 32, to which detection voltage U_D of Nernst measuring cell 12 is applied.

Pump cell 14 includes a first electrode 38 (inner pump electrode) and a second electrode 40 (outer pump electrode) between which a solid electrolyte 42 is arranged. Solid electrolyte 42 is in turn made of, for example, a yttrium-oxide-stabilized zirconium oxide, while electrodes 38 and 40 may in turn be made of platinum. Electrode 38 is also arranged in hollow space 28 and is thus also exposed to exhaust gas 24 via diffusion barrier 22. Electrode 40 is covered by a protective layer 44, which is porous, so that electrode 40 is directly exposed to exhaust gas 24. Electrode 40 is connected to an input 46 of circuit arrangement 32, while electrode 38 is connected to electrode 16 and, along with it, is connected jointly to input 34 of circuit arrangement 32. This joint supply conductor of electrodes 16 and 38 connected to circuit arrangement 32 will be discussed in greater detail below with reference to Figures 2 and 3.

Probe 10 also includes a heating device 49 which is formed by a meandering heating element and to which a heating voltage U_H can be applied.

Probe 10 functions as follows:

Exhaust gas 24 enters hollow space 28 via measuring opening 26 and diffusion barrier 22 and is thus present at electrode 16 of Nernst measuring cell 12 and electrode 38 of pump cell 14. A difference in the oxygen concentration at electrode 16 and that at electrode 18, which is exposed to the reference gas, arises based on the oxygen concentration in the exhaust gas to be measured. Electrode 16 is connected to a current source of circuit arrangement 32, which supplies a constant current, via terminal 34. A specific detection voltage U_D (Nernst voltage) arises based on a difference between the oxygen concentration present at electrode 16 and that at electrode 18. Here, Nernst measuring cell 12 functions as a lambda sensor that detects whether a high oxygen concentration or a low oxygen concentration is present in exhaust gas 24. It is clear from the oxygen concentration whether the fuel/air mixture used to operate the internal combustion engine is a rich or a lean mixture. If there is a change-over from the rich range to the lean range or vice versa, detection voltage U_D drops or increases, respectively.

With stoichiometric operation, i.e., with a lambda value = 1, detection voltage U_D has a jump point that marks the transition from a lean range to a rich range or vice versa, respectively.

With the help of circuit arrangement 32, detection voltage U_D is used to determine pump voltage U_P, which is applied to pump cell 14 between its electrodes 38 and 40, respectively. Pump voltage U_P is negative or positive based on whether detection voltage U_D signals that the fuel/air mixture is in the rich or lean range, so that electrode 40 is connected either as a cathode or as an anode. Accordingly, a pump current I_P is established and can be measured via a measuring device of circuit arrangement 32. With the help of pump current I_P, oxygen ions are pumped from electrode 40 to electrode 38 or vice versa. Measured pump current I_P is used to control a device for setting the fuel/air mixture used to operate the internal combustion engine.

The detection voltage circuit (Nernst voltage circuit) and the pump voltage circuit are coupled to circuit arrangement 32 via the joint supply conductor of electrodes 16 and 38, respectively. In Figure 2, an equivalent circuit diagram illustrating how electrodes 16 and 38 are connected to circuit arrangement 32 is shown. It is clear from the equivalent circuit diagram that electrode 38 is initially connected to a contact point 52 via a printed conductor section 50. Electrode 16 is also connected to contact point 52 via a printed conductor section 54. A printed conductor section 56 connects contact point 52 to input 34 of circuit arrangement 32. Contact point 52 is arranged inside probe 10 and is located at a geometric distance a from electrodes 16 and 38, respectively, indicated here. A geometric distance b for joint supply conductor section 56 of electrodes 16 and 38 results, corresponding to section a.

Conductor section 50 has an internal resistor R1, conductor section 54 has an internal resistor R2, and conductor section 54 has an internal resistor R3. Resistors R1, R1, and R3 form a loaded voltage divider, the constant current applied to Nernst measuring cell 12 flowing via conductor sections 54 and 56, while pump current I_P flows via conductor sections 50 and 56.

Figure 3 shows a first embodiment variant for arranging the loaded voltage divider formed by resistors R1, R2, and R3. An additional resistor R4 is connected between terminal 34 and circuit arrangement 32 (Figure 1). This effectively increases the resistance value of joint supply conductor section 56 of electrodes 16 and 38, the resistance being the sum of

resistances R3 and R4. Thanks to this greater resistance R3 + R4, the Nernst voltage increases given the constant current applied to Nernst measuring cell 12 via circuit arrangement 32.

According to the embodiment variant shown in Figure 3b, contact point 52 is moved geometrically closer to electrodes 16 and 38, so that the length of joint supply conductor section 56, i.e., distance b' between contact point 52 and terminal 34, is increased. As a result, the resistance value of resistor R3 is increased relative to the initial embodiment shown in Figure 2. In particular, this causes supply conductor resistor R3 to have a positive temperature coefficient.

According to a further embodiment variant (not shown), joint supply conductor section 56 between contact point 52 and terminal 34 may have a smaller cross section than that of sections 50 and 54, respectively, so that as a result the resistance value of resistor R3 increases.

Patent Claims

1. A probe for determining an oxygen concentration in a gas mixture, in particular in the exhaust gas of internal combustion engines, having a Nernst measuring cell, which has a first electrode (Nernst electrode) which is exposed to the gas mixture to be measured via a diffusion barrier, a second electrode (reference electrode) which is exposed to a reference gas, and a solid electrolyte body arranged between the first and the second electrode, and having a pump cell, which has a first electrode (inner pump electrode) which is exposed to the gas mixture via the diffusion barrier, a second electrode (outer pump electrode) which is exposed to the gas mixture, and a solid electrolyte body arranged between the first and the second electrode, the Nernst electrode and the inner pump electrode being connected at least in some sections via a joint supply conductor to a circuit arrangement for controlling and evaluating the probe, characterized in that a joint supply conductor resistor (R) of the Nernst electrode (16) and of the inner pump electrode (38) is formed by a loaded voltage divider whose individual resistors (R1, R2, R3) are arranged so that the negative feedback of a Nernst voltage circuit and of a pump voltage circuit is optimized, in particular maximized.

2. The probe according to Claim 1, characterized in that an additional external resistor (R_4) is connected in series to the joint supply conductor section (56) of the Nernst measuring cell (12) and the pump cell (14).

3. The probe according to one of the preceding claims, characterized in that a cross section of the joint supply conductor section (56) is minimized.

4. The probe according to Claim 3, characterized in that the cross section of the supply conductor section (56) is smaller than a cross section of printed conductor sections (50, 54) via which the electrodes (16, 38) are connected to the contact point (52).

5. The probe according to one of the preceding claims, characterized in that a contact point (52), as far as which the electrodes (16, 38) are connected to the circuit arrangement (32) via the joint supply conductor section (56), is located directly downstream of the electrodes (16, 38) at a distance (a'), so that a distance (b') of the supply conductor section (56) is of maximum length.

Abstract

A probe is described for determining an oxygen concentration in a gas mixture, in particular in the exhaust gas of internal combustion engines, having a Nernst measuring cell, which has a first electrode (Nernst electrode) which is exposed to the gas mixture to be measured via a diffusion barrier, a second electrode (reference electrode) which is exposed to a reference gas, and a solid electrolyte body arranged between the first and the second electrode, and having a pump cell, which has a first electrode (inner pump electrode) which is exposed to the gas mixture via the diffusion barrier, a second electrode (outer pump electrode) which is exposed to the gas mixture, and a solid electrolyte body arranged between the first and the second electrode, the Nernst electrode and the inner pump electrode being connected at least in some sections via a joint supply conductor to a circuit arrangement for controlling and evaluating the probe.

A joint supply conductor resistor (R) of the Nernst electrode (16) and of the inner pump electrode (38) is formed by a loaded voltage divider whose individual resistors (R1, R2, R3) are arranged so that the negative feedback of a Nernst voltage circuit and of a pump voltage circuit is optimized, in particular maximized.

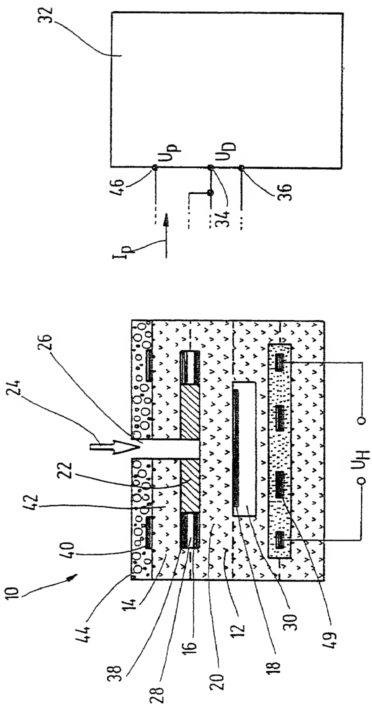

Fig.1

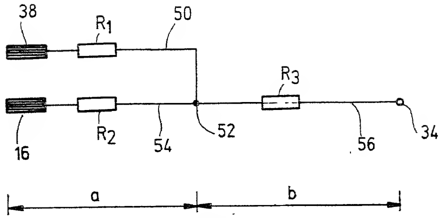

Fig. 2

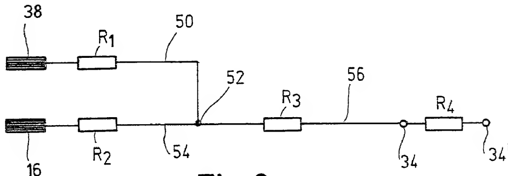

Fig. 3a

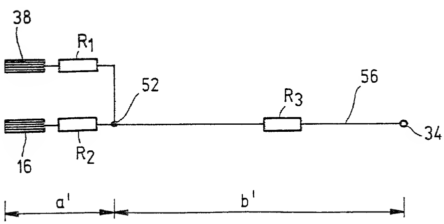

Fig. 3b

R. 33880

[10191/1376]

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **PROBE FOR DETERMINING THE OXYGEN CONCENTRATION IN A GAS MIXTURE**, the specification of which was filed as International Application No. PCT/DE99/02124 on July 9, 1999 and as U.S. Application, Serial No. 09/554,041.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EL302701208

PRIOR FOREIGN APPLICATION(S)

Number	Country Filed	Day/Month/Year	Priority Claimed Under 35 USC 119
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And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and Gerard A. Messina (Reg. No. 35,952) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

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